Energy Storage

Regulatory and Policy issues

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tion

आशावधिं को गत:

(There is no limit of aspirations, expectations and needs)

on

Grid Resilience

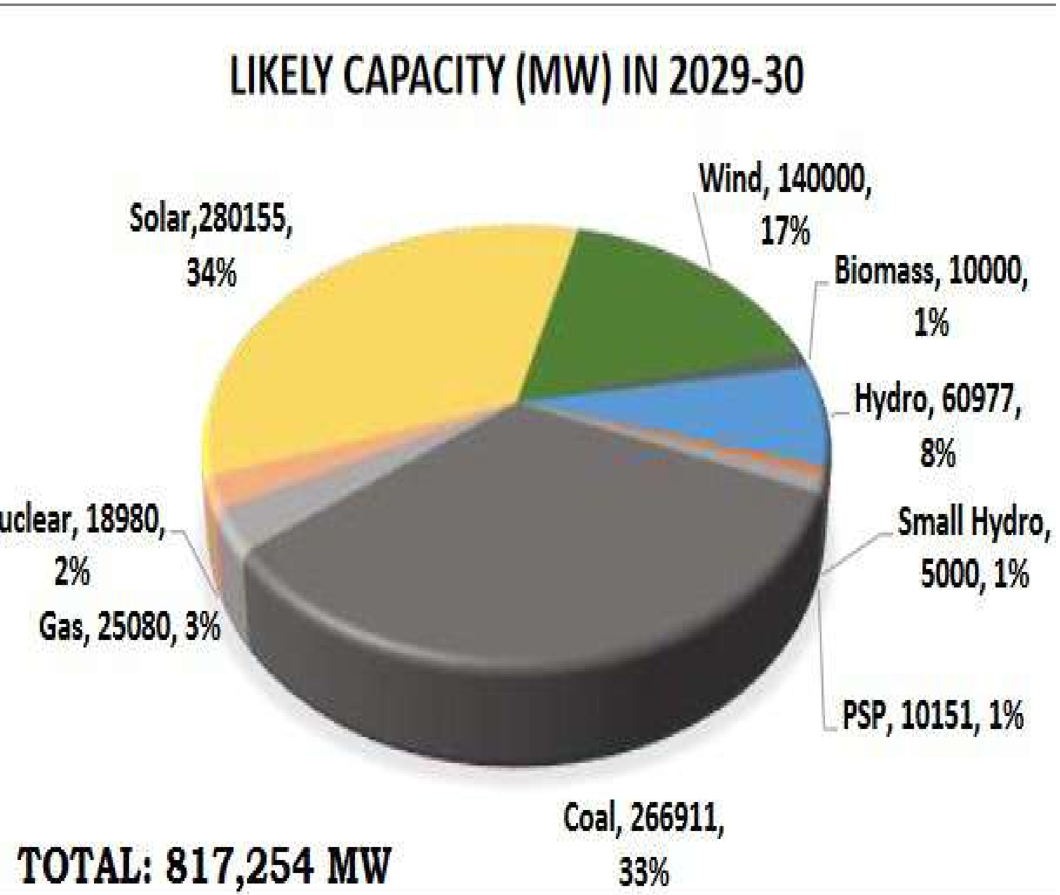
Flexibility

Affordable Power

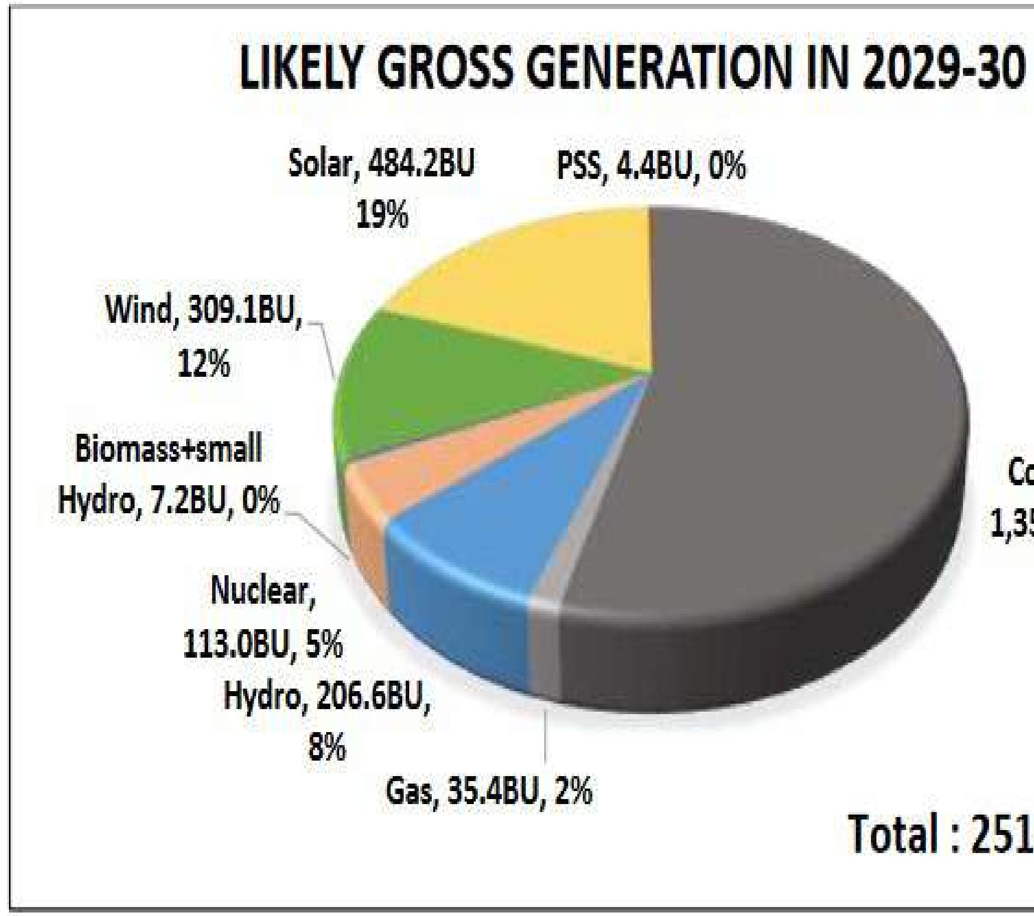
Objective

- Energy storage is one of the key technologies for a future power grid with high penetration of renewable energy due to its capability to separate the production and consumption of electrical energy from time and space (Li and Hedman, 2015).
- Duck Curve or Swan curve , there is need of Storage.
- “To accelerate growth, the storage industry needs regulatory structures that clarify who can own energy storage systems and reward network owners for reducing capex.”: BloombergNEF 31.3.2021
- So the question Why is settled and we all agree that it is required.
- Now issue is when , how much and **with what policy and regulatory** support it can come quickly.

2029-30



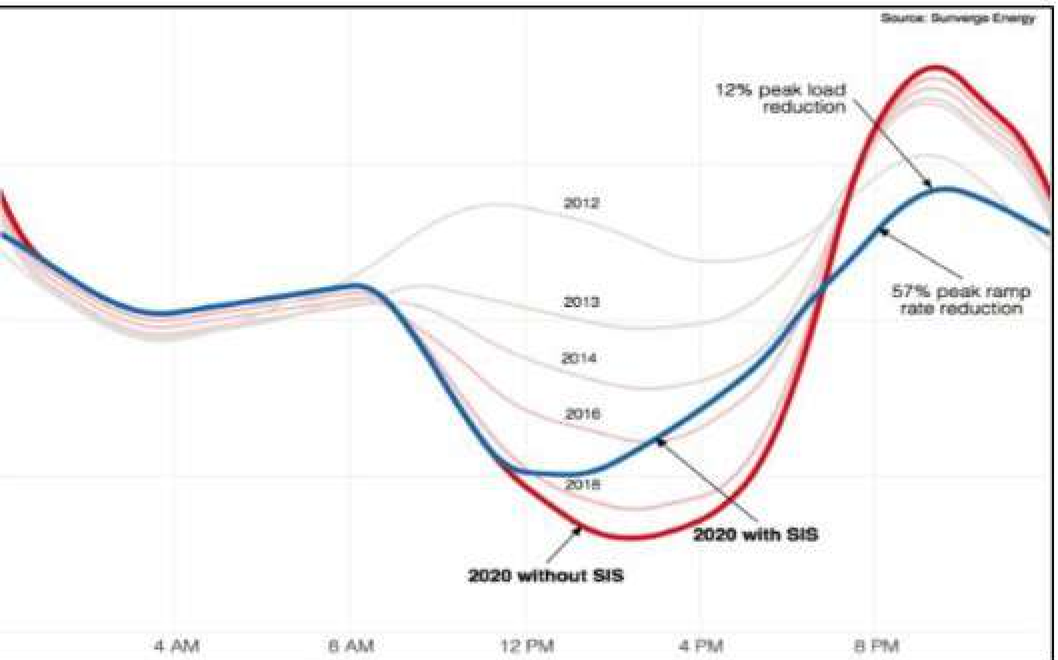
LIKELY CAPACITY (MW) IN 2029-30
Solar,280155, 34%
Wind, 140000, 17%
Biomass, 10000, 1%
Hydro, 60977, 8%
Small Hydro, 5000, 1%
PSP, 10151, 1%
Coal, 266911, 33%
Gas, 25080, 3%
uclear, 18980, 2%
TOTAL: 817,254 MW



LIKELY GROSS GENERATION IN 2029-30
Solar, 484.2BU 19%
PSS, 4.4BU, 0%
Wind, 309.1BU, 12%
Biomass+small Hydro, 7.2BU, 0%
Nuclear, 113.0BU, 5%
Hydro, 206.6BU, 8%
Gas, 35.4BU, 2%

Need Agreed

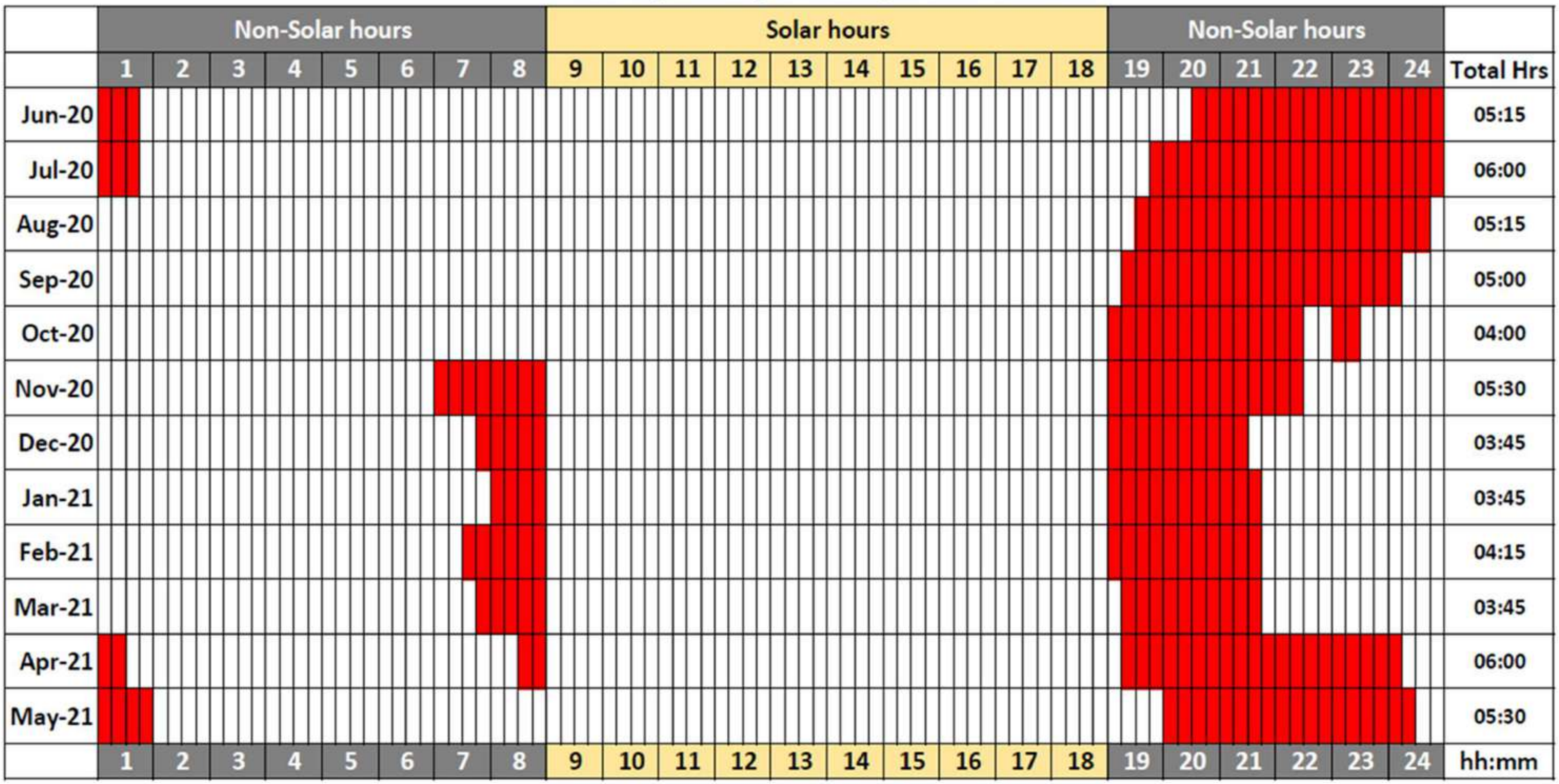
igure 3: Duck Curve Phenomenon example with and without storage



e: http://www.sunverge.com/integrated-energy-storage-an-answer-to-addressing-the-duck-curve

Opportunity for Storage?

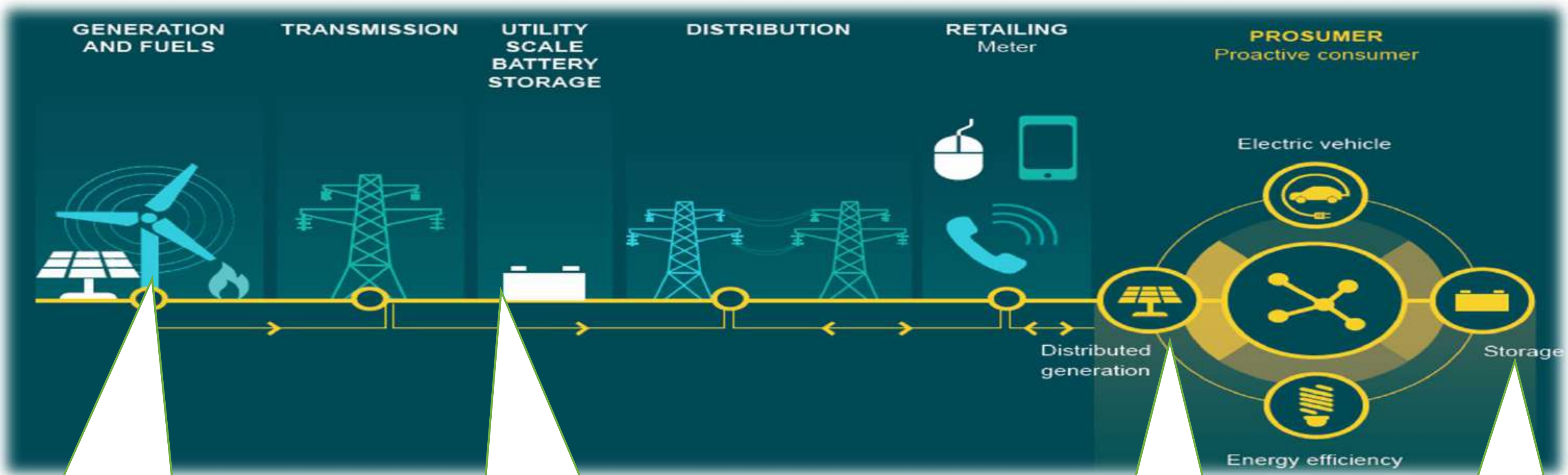
All India Demand (Monthly Scenario) in Non-Solar hours



Highlighted (high) demand hours (non-solar) : demand more than 95% of peak demand (Apr-Sep), 92% for Oct & Mar and 85% for (Nov-Feb)

@POSOCO India

Storage across Value Chain



l scale solar and wind
inject variability
tilization of transmission
system

Grid storage absorbs
grid variability
Improves utilization of
transmission system

Distributed solar
injects local
variability

Distributed
absorbs va

Future

Likely Installed capacity by the end of 2029-30

Fuel Type	Capacity (MW) in 2029-30	Percentage Mix (%)
Hydro *	60,977	7.46%
PSP	10,151	1.24%
Small Hydro	5,000	0.61%
Coal + Lignite	2,66,911	32.66%
Gas	25,080	3.07%
Nuclear	18,980	2.32%
Solar	2,80,155	34.28%
Wind	1,40,000	17.13%
Biomass	10,000	1.22%
Total	**8,17,254**	
Battery Energy Storage#	27,000MW/108,000MWh	

* including hydro imports of 5856 MW # Active Battery Storage.

he next phase of energy transition driven by the large-scale deployment of variable renewable energy sources
e solar and wind power can be fully realized by key technologies of Energy Storage. The grid integration
allenges of the intermittent generation sources ensuring quality of supply on real time basis along with the ca
store excess electricity over different time horizons (minutes, days, weeks) can be achieved by the electricity
tems.

CEA, Ministry of Power Report on Optimum Generation Mix for 2029-30 (Final report : Jan,2020)

rtainty: More frequent Extreme Weather

USA

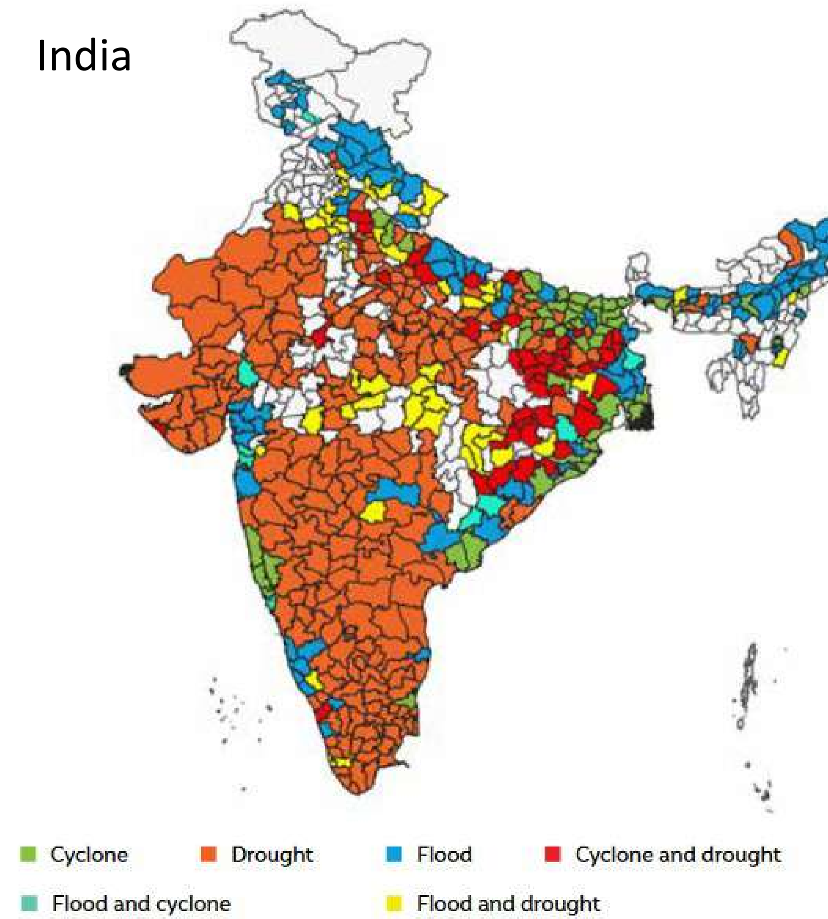
The Texas "deep freeze" of February 2021 resulted in deaths estimated to number between 200 and 700, most due to the power outage, and an estimated $90 billion in damages.

Wildfires in California have caused utilities to institute recurring preemptive power outages. Damages from pacific gas & electric's preemptive outages have been estimated at $2.5 billion in 2019 alone.

Hurricane Maria caused some 3,000–4,000 deaths in Puerto Rico,3 many attributable to power outages, with damage estimates ranging from $45 billion to $95 billion.

Superstorm sandy caused 8.5 million customer outages across 21 eastern states, some lasting weeks or even months, with damages estimated up to $26 billion.

India



The number of associated cyclonic events increased 12-fold between 1970 anc
@Abinash Mohanty @CEEW

an,2017

CERC Staff Paper on Introduction of Electricity Storage System in India :

1.9 At present, there are various uncertainties on practical use of storage echnology, performance of new storage technologies in the Indian environment, its applications and **the governing market rules for operating torage technologies in the grid**. These uncertainties may inhibit the interest nd acceptance in storage technologies for investment and utilization by the takeholders.

.10.
We believe that well established policy and regulatory framework for the SS at this infancy stage may channelize the investment in this segment of he power"

Regulatory and Policy Measures

- Inclusion of Storage in Policy and Plan
- Target for Storage Deployment
- Energy Strategy promote operational flexibility
- Support Organized Knowledge Sharing and Delivery
- Domestic industrial policy support Storage Manufacturing
- Targeted Support to early adopters-Subsidy , Taxation, Interest

Based on @NREL Energy Storage Assessment Model

ENERGY INDEPENDENCE AND SECURITY ACT OF 2007

- United States Energy Storage Competitiveness Act of 2007''.
- Section 640 :
- (c) PROGRAM.—The Secretary shall carry out a research, development, and demonstration program to support the ability of the United States to remain globally competitive in energy storage systems for electric drive vehicles, stationary applications, and electricity transmission and distribution.
- (4) PLANS.—No later than 1 year after the date of enactment of this Act, and every 5 years thereafter, the Council, in conjunction with the Secretary, shall develop a 5-year plan for integrating basic and applied research so that the United States retains a globally competitive domestic energy storage industry for electric drive vehicles, stationary applications, and electricity transmission and distribution.

Promoting Grid Storage Act of 2019

SEC. 3. Energy storage research program.

(a) In general.—The Secretary shall establish a cross-cutting national program within the Department of Energy for the research of energy storage systems, components, and materials.

(b) Additional requirements.—In establishing the program under subsection (a), the Secretary shall—

(1) identify and coordinate across all relevant program offices throughout the Department of Energy key areas of existing and future research with respect to a portfolio of technologies and approaches; and

(2) adopt long-term **cost, performance, and implementation targets** for specific applications of energy storage systems.

nclusion of Storage in Policy and Plan

India is yet to include Storage in its Policy , although in various draft issued in past, Storage was mentioned :

1. Draft National Energy Policy , NITI Aayog, 2017(27.6.17 version)

   "In order to counter the intermittency in supply of renewable energy, there needs to be a push towards integrating the same with gas based power plants and the development of storage technologies "

2. Draft Tariff Policy 2018 (Major emphasis on Pump Storage)

lational Electricity Plan –January 2018

Storage technology is in nascent stage and it would be premature to discuss in detail in NEP about s implementation impact in load management vis-a-vis cost-effectiveness."

ituation Changed dramatically when discussion started on target of 450 GW RE for 2029-30

atest Good News :

High Power committee with four sub groups is preparing Draft Energy Storage Policy and omments of Stakeholders also sought by 31.10.2021.

o by the end of this year first target would be achieved.

Connectivity Condition

- In some countries Storage obligation is implemented through Connectivity Regulation.
- In Draft CEA Connectivity Regulation 2017 it was attempted :

> Provided that wind generating station and inverter based generating stations having capacity 50 MW or more shall have storage capacity of at least 10% of installed capacity as common facility irrespective of generation capacity owned/ developed by different owners/developers.

nal Regulations :(4) The generating stations with installed capacity of more than 10 MW connected a
ltage level of 33 kV
nd above –
shall be equipped with the facility to control active power injection in accordance with a set point,
pable of being revised based on directions of the State Load Dispatch Centre or Regional Load
spatch Centre, as the case may be;
rovided that for frequency deviations in excess of 0.3 Hz, the Generating Station shall have the
cility to provide an immediate (within 1 second) real power primary frequency response of at least
0% of the maximum Alternating Current active power capacity

Target for Storage Deployment

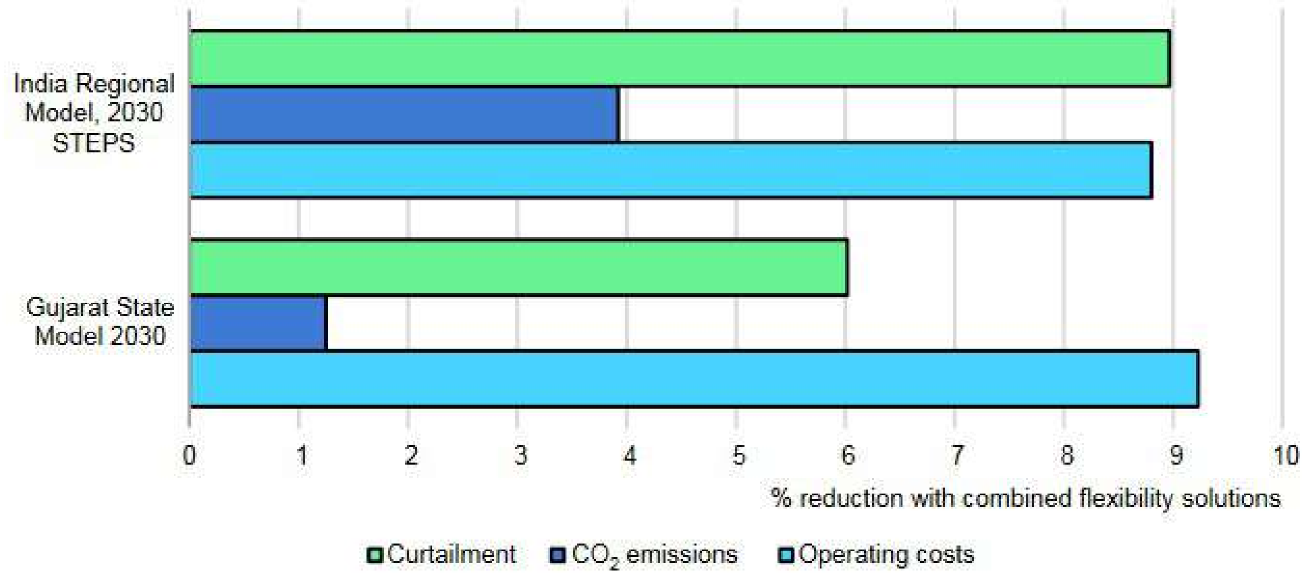
- At present no specific target for Utility Scale Storage or Behind the meter (BTM) Storage.
- Targets are helpful in giving certainty to investment . The capex in Battery manufacturing need long term visibility.
- For example 175 GW RE target drove tariff down.
- Target need to be broken into smaller phase wise target .
- Example:
- State of California, USA enacted a Law in October, 2010 requiring the California Public Utilities Commission (CPUC) to establish appropriate energy storage procurement targets for California load serving entities for 2015 and 2020, if cost effective and commercially viable by October, 2013.
- In June 2013, the CPUC proposed storage procurement targets and mechanisms totaling 1,325 MW of storage which indicates the possible viability in storage technologies.
- CEA view is that during initial years existing and planned Pump storage capacity would help in managing the grid and 2027-28 onward BESS would be required.
- However these values are based on system balance for RE integration only and other usage like Ancillary services, Energy arbitrage and transmission deferral were not considered.

Energy Strategy promote operational flexibility

- To integrate RE , generation mix having operational flexibility is required.
- Regulatory Steps taken:
- IEGC mandated Technical Minimum of 55% for Interstate Generating stations.
  - Impact: Nil curtailment of ISTS connected RE generator and also help in manging variability of Intra state generation by giving state flexibility in scheduling. (Reduction of curtailment from 3.5% to 1,4% and saving in operating cost by 0.9% (Ref: Palchak et 2017)
- For further flexibility : Pilot case study on impact of lowering technical Minimum to 40% on Central and state sector plants with help of USAID.
- However in many State the technical Minimum of 55% is still to be adopted and most of them following 70% technical Minimum
- However state wise flexibility matrix are different , some state do not have enough flexibility resources like Hydro and Gas. So Storage is needed there. Regulatory Intervention to initiate Pilot Project is required.

Benefit of flexibility

Reduction in curtailment, CO_2 emissions and operating costs due to combined flexibility options in India and Gujarat



Note: Percentage savings show the impact of increased flexibility from power plants, demand response, energy storage and transmission in the IEA India Regional Power System Model and Gujarat State Power System Model.

However to incorporate flexibility in thermal stations not only more investment would be needed but also due to high wear and tear operational cost would increase.

“Coal plants are expected to operate less as renewable technologies supply more generation, which leads to reduced revenues. At the same time, to operate flexibly and meet stricter emissions standards, some coal plants may also require further investment. Such investment needs to be weighed against investment in flexibility
sources in other parts of the system (storage, demand and grids) and emission reduction targets.” IEA

So a regulatory call needs to be taken to operate many plants on sub optimal load or closing the costliest and manage the flexibility through Storage.

Support Organized Knowledge Sharing and Delivery

- At policy and Regulatory level , organized knowledge sharing of R&D and Delivery is must.
- New York State Energy Research and Development Authority (NYSERRDA) is responsible for allocating state funds to implement storage incentive programs and also serves as the clearinghouse for information on incentives and technical resources for installing and operating energy storage facilities, opportunities for researchers and manufacturers to develop new energy storage technologies, and the state’s progress toward its clean energy goals.

Domestic industrial policy support Storage Manufacturing

- For a critical component of energy security , no nation can depend fully on import.
- Storage Manufacturing support policy is important tool for technology adoption and employment generation and transition.
- In January 2019, Prime Minister Modi announced a National Mission on Transformative Mobility and Battery Storage to develop more factories to produce batteries and electric vehicles (GOI 2019c).
- As part of this goal, 25%–40% of the batteries for electric vehicles would be met through domestic manufacturing initiatives.
- The mission includes a 5-year phased manufacturing program to set up large-scale battery giga-factories.
- In the state of Andhra Pradesh, Urja Global, a solar and battery manufacturing firm, is investing in production centers (Deign 2019).

PLI scheme

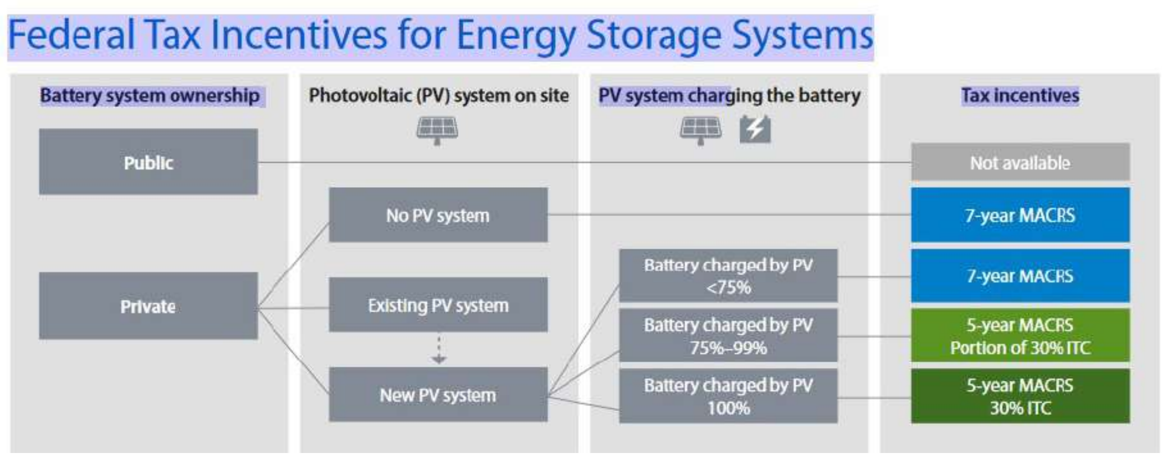
- The Government on 12.5.2021 has approved the Production Linked incentive Scheme (PLI) for manufacturing of Advance Chemistry Cell (ACC) in the country. The total outlay of the scheme is Rs.18,100 crore for five years. The scheme envisages establishing a competitive ACC battery manufacturing set up in the country (50 Giga Watt hour-GWh). Additionally, 5 GWh of niche ACC technologies is also covered under the scheme.
- The scheme proposes a production linked subsidy based on applicable subsidy per KWh and percentage of value addition achieved on actual sales made by the manufacturers who set up production units.
- The PLI scheme will facilitate reduction of import dependence of ACC battery, which is imported presently.
- Reliance Industries Ltd (RIL), Adani Group, Tata Chemicals, Larsen and Toubro Ltd (L&T), and a joint venture (JV) led by Japan's Suzuki Motor Corp. are among companies who have shown interest in building lithium-ion cell manufacturing plants in India
- The manufacturing facility as proposed by the beneficiary firm would have to be commissioned within a period of 2 years. The subsidy will be disbursed thereafter over a period of 5 years.
- Mineral exploration: Preliminary surveys on surface and limited subsurface exploration by AMD have shown presence of Lithium resources of 1,600 tonnes (inferred category) in the pegmatites of Marlagalla – Allapatna area, Mandya district, Karnataka.

Targeted Support to early adopters-Subsidy , Taxation, Interest

- Both Type of Energy Storage system i.e BESS and PHS need initial support.
- The price of battery storage system are falling rapidly but still it is costlier than other energy sources. Similarly PHS whether off stream or river based need initial financial support due to high cost.
- All advance countries are supporting Energy storage through subsidy , interest subvention, tax rebates, accelerated depreciation benefit also.
- On Similar ground in India it is proposed to grant relaxation in custom duty , GST , interest subvention and tax holiday. It is expected that these will results in cost reduction by 11- 19%.
- Although at present for BTM installation no such proposal is under consideration but soon for domestic and commercial customers , it would be consider.

xamples of Incentives

- Germany is shouldering 30% of the installation costs of solar power generation–related ESSs with an ESS installation subsidy, for a total of about €150 million over 6 years.
- Japan also provided 31 billion yen in subsidies until 2015 in order to develop the industrial ecosystem for ESSs with the goal of capturing 50% of the global market by 2020.
- IN US Many states are providing Interest credit relief or accelerated depreciation.
- Republic of Korea is supporting ESS market penetration by extending the application of weighted value to renewable energy–related ESSs such as Photovoltaic 5.0 until 2019



Regulatory Touch Points

- Tariff under different business Model
- Connectivity
- Transmission Charges
- Service Compensation
- Safety of operation
- Safe Disposal

Potential Energy Storage Services

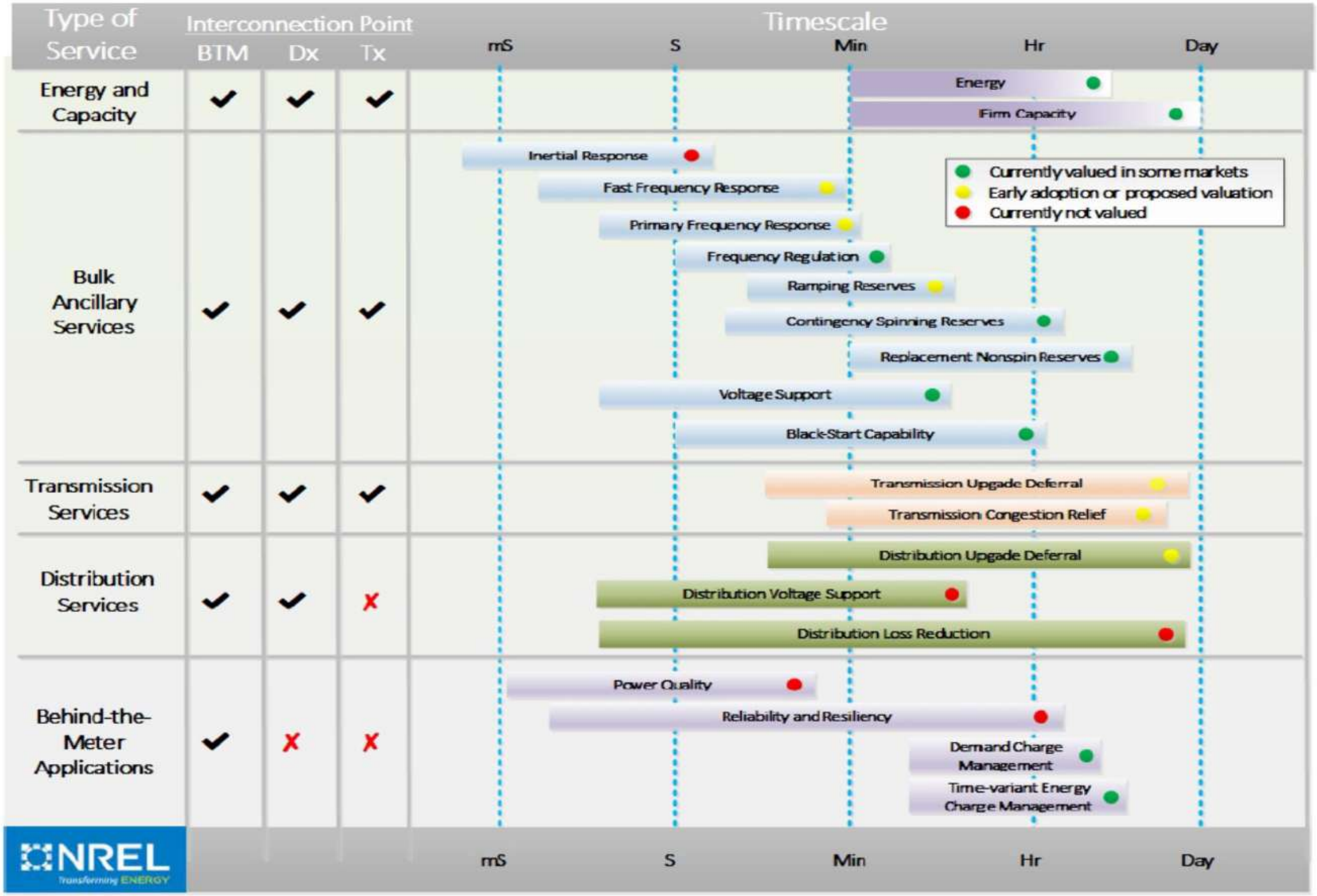


Figure 3: Summary of potential battery energy storage services and required response times and durations

Source: Original [*Illustration by Vahan Gevorgian, Paul Denholm & Owen Zinaman, NREL]*

Tariff under different business Model

Energy Storage can come through Regulated Tariff Mechanism or Market Based Mechanism.

Possible Business Models:

- As part of Renewable Generation Asset
- With Transmission asset
- Asset for Balancing Services and Flexible Operation
- Distribution System asset
- Combination of above
- Behind The Meter Asset of Consumer in which Regulator has to play role of facilitator

ndia's First Grid Scale

First Storage installation by Tata Power-DDL in collaboration with AES and Mitsubishi an as part of RTM.

The 10 MW Battery Energy Storage System (BESS) can be utilized for the following innovative applications:

- Grid Stabilization

- Peak Load Management

- Overload Mitigation of Power Transformer

- Volt-Var Regulation

- Reactive Power Management

- CAPEX Deferral

- Frequency Regulation Ancillary Services

- Deviation Settlement Mechanism

- Life Enhancement of the Asset

Recovery Mechanism under Regulated

- Capex /Opex Model
- Pass Through in ARR as Capex
- Two part Tariff –Fixed Charges & Energy Charges
- Tariff Design Model – TOD etc
- Utility to se off with saving in penalty cost , deferred capex etc

Market Based

In place of plain vanilla RE projects , to cater system need and consumer requirement RE project with storage facility are bided.

In August 2019 SECI invited bids for RE plus storage bid for ISTS Tranche –VII

SECI: ISTS Tranche-VII 1.2 GW RE Peak Power Supply

MERCOM india research

Auction Results for 1,200 MW RE Peak Power (Solar, Wind, Storage) Projects							
Bidder/Developer	Capacity	Peak Tariff		Off-Peak Tariff		Weighted Average Tariff*	
	MW	₹/kWh	$/kWh	₹/kWh	$/kWh	₹/kWh	$/kWh
Greenko	900	6.12	*0.086*	2.88	*0.040*	4.04	*0.057*
ReNew Power	300	6.85	*0.096*	2.88	*0.040*	4.30	*0.060*

Note: The weighted average is based on the normative capacity utilization factor of 35% as mandated by SECI.

**The weighted average figures are from the developer* *Note: $1 = ₹71.5*

Source: Mercom India Research

Market Based

Most of the countries are following market based tariff mechanism where Energy Storage are selected based on competitive bidding on Build Own Operate (BOO) model.

The bidding parameters may be :

(A) Capacity Charges : Availability based fixed charges (per kWh or per MW)

(B) Energy Charge (Rs per kWh)

(C) Subsidy or VGF support required by the bidder for a pre specified fixed tariff

Or combination thereof

Connectivity

- CEA has amended Technical Standards for Connectivity to the Grid enabling storage devices and Charging infrastructure
- CERC Connectivity and Long Term Access to the ISTS facilitate connectivity to the Storage , whether as stand alone or alonwith RE Project.
- At present separate application for injection and withdrawal is required and as per stakeholders views, this need to be simplified into single application .
- For expediting the approval and to minimize the cost , the position of vacant bays on existing ISTS substation is published on CTU open access website.

Transmission Charges

In India , Renewable projected connected to the Inter State Transmission system are exempted from payment of Transmission Charges till 30Th June,2025.

Ministry of Power vide order dated 21.6.2021 extended this exemption to storage projects also , however with certain riders of charging through renewable Energy.

- Waiver of total Inter- State transmission system (ISTS) charges shall also be allowed for Hydro Pumped Storage _Plant (PSP) and Battery Energy Storage System (BESS)projects to be commissioned 30th June 2025, if following conditions are met·:
  - at _least 70 % - of the annual electricity requirement for pumping of water in the Hydro Pumped Storage Plant or charging of battery in BESS is met by use of electricity generated from solar and/or wind power plants.
  - 25% of STOA charges for first 5 yearsand then to be increased gradually

Service Compensation

The most important part of Storage is investment recovery through service. The revenue stream of Storage is based on the concept of " Value Stacking". Only by providing multiple services at different time of the day , it can recover its cost.

For this important conditions are:

- Electric Service Charges reflect the Value of Energy Services.
- Storage able to Compete with other Grid assets to provide Multiple Service
- Storage able to receive revenue for multiple service

Even after best efforts few services provided by Storage may remain unpaid.

Type of Grid Level Storage services

Type of Service	Description	Timescales (Text block: response time; Shaded area: response duration) — mSec / Sec / Min / Hr / Day
Energy and Capacity	Effectively increase available load during periods with excess generation for peak demand management and reducing renewable energy curtailment	Energy Arbitrage
	Stabilize net electricity demand to minimize thermal unit ramping and cycling and minimize errors in renewable energy and demand forecasts	Load Following
	Provide capacity to meet generation requirements during peak loading periods and contingency events	Resource Adequacy
Ancillary Services	Provide power to maintain generation-load balance and prevent frequency fluctuations	Frequency Regulation
	Inject or absorb incremental voltage to maintain voltage stability on the transmission system	Voltage Regulation
	Provide immediate response to maintain electricity output during contingency events	Spinning Reserve
	Maintain electricity output during contingency events within a short time period	Non-spinning Reserve
	Start main turbine of grid-connected generator or feed power into the grid so that other plants can start up and restore power	Black Start
Transmission	Provide extra capacity to meet anticipated load growth for the purpose of delaying, reducing, or avoiding transmission system investments	Upgrade Deferral
	Absorb power to reduce network congestion	Congestion Management

Source: NREL

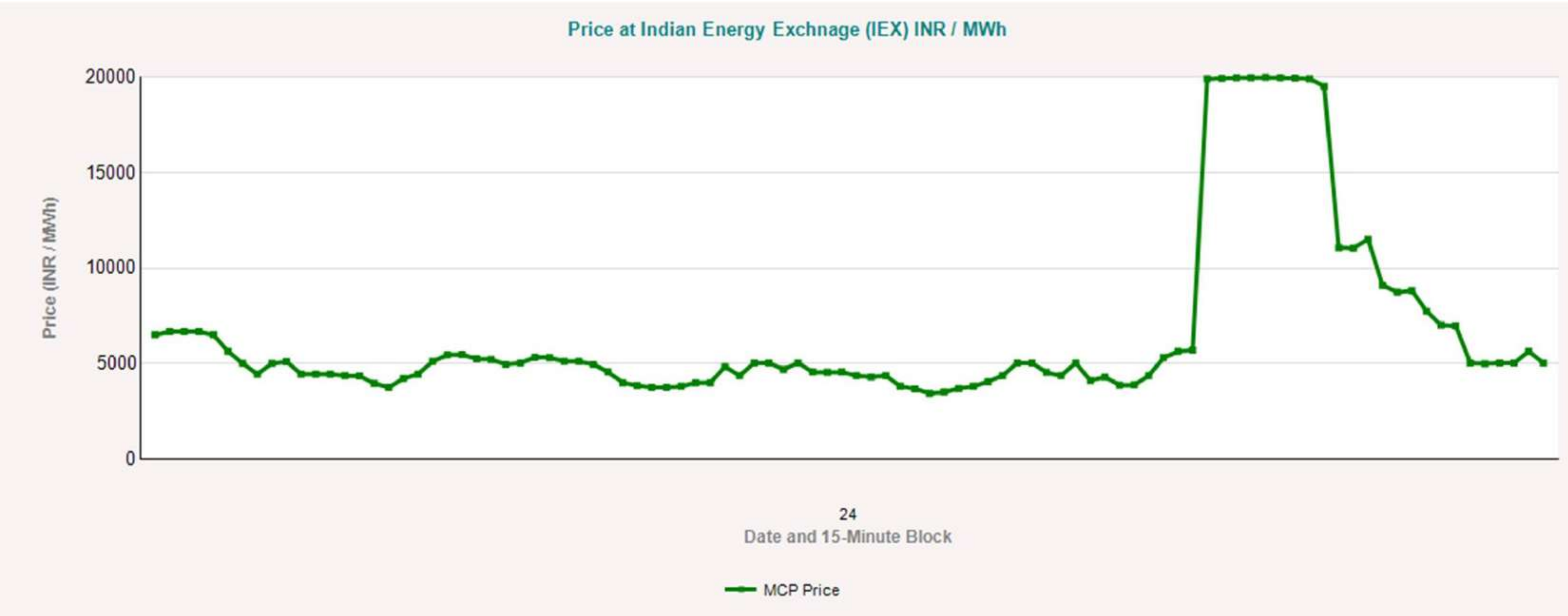
Energy Arbitrage

Th opportunity for Energy Arbitrage depends on Market design .

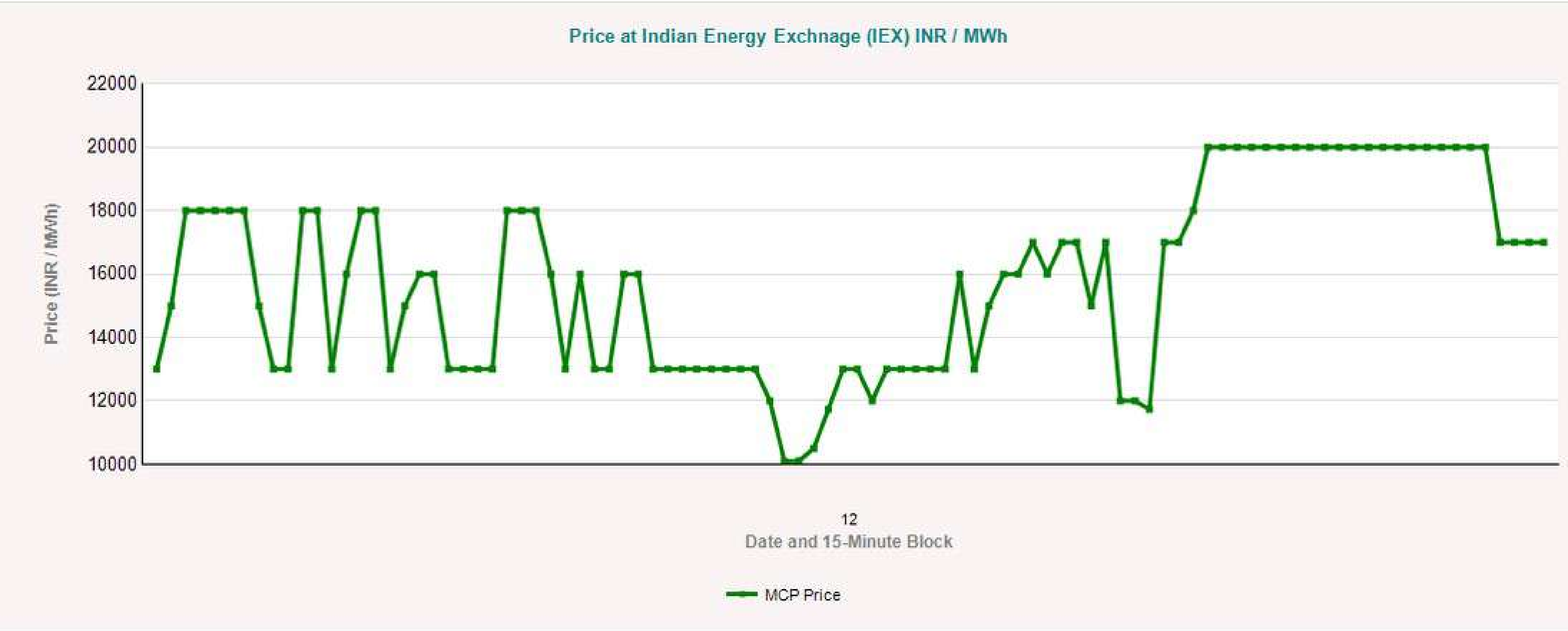
The ability of energy storage to receive compensation for energy time-shifting (i.e., buy low, sell high) has the largest impact on both near-term and long-term storage deployment. By 2030, the energy capacity of storage technologies is 57% lower in the No ES Time-shifting Value scenario compared to the Reference Case and 76% lower by 2050. (NREL, India Storage study)

This scenario represents an environment in which energy storage projects are not able to monetize (i.e., receive revenue) for the time-shifting service that they provide to the grid. This scenario could happen in a contract structure in which a single tariff does not correctly account for the changing price of energy throughout the day. (Explain it) Example Singapore vs India

24.9.21


Price at Indian Energy Exchnage (IEX) INR / MWh
20000
15000
10000
5000
0
Price (INR / MWh)
24
Date and 15-Minute Block
MCP Price

12.10.21

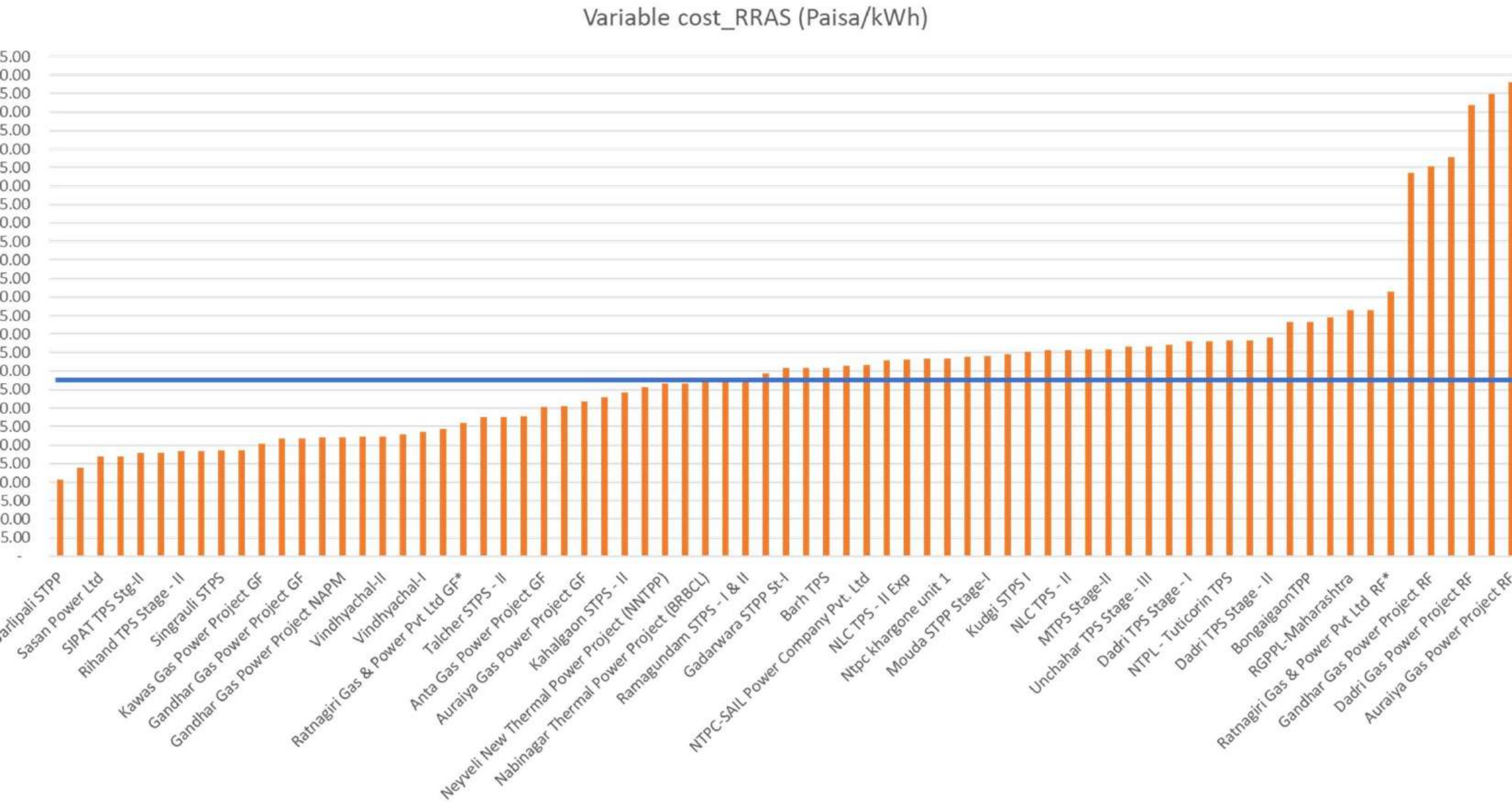


Price at Indian Energy Exchnage (IEX) INR / MWh
22000
20000
18000
16000
14000
12000
10000
Price (INR / MWh)
12
Date and 15-Minute Block
MCP Price

Ancillary Services

- Regulatory mechanism should facilitate participation of Storage in Ancillary Service Market.
- Earlier only Un-Requisitioned Surplus (*URS*) *Power* of ISGS was being used for Ancillary Service in Tertiary response
- Draft CERC Ancillary Service Regulation 2021 now open Secondary and Tertiary response for Storage. However as per their characteristic Storage is suitable for Primary response for which there is no market at present as it is mandatory for conventional generator.
- If payment through these services is considered , Storage would at present will be only partially utilised , unless through Regulatory Mandate it is used on First Charge basis.
- Due to overhang of surplus capacity ,it would be difficult for Storage to compete unless special provision is given. Also prices in Ancillary service at present is attractive.

Variable cost Merit Orderof Regulated Entities



Ancillary Service by Storage

- Value Stacking : As per Value Stacking principle , at present any Energy Storage system become viable only if it provide Multiple Services. So flexibility Service is one of the revenue source .
- In any integrated grid , total Ancillary service is about 3-5 % , so if Storage want to participate it then it can do on the basis of its characteristic i.e very fast response.
- So regulatory and policy mechanism should give a certain “Value” to this service. Else with capacity overhang in energy market in India, it would be difficult for storage to participate in this .
- Recent draft Ancillary Service market Regulation by CERC give an opportunity to Storage to participate on the basis of fast Ramp , but as per stakeholders comments , selection criteria for secondary response need to be tweaked and some primary response market should also be explored.
- In UK Under Ancillary service a “ Very Fast Response Service” provide this exclusive opportunity .

mpact on operating reserve

If Storage service donor provide Ancillary service and not treated as operating reserves then overall cost of providing reserve increased.

A 3.3% increase in annual production cost when storage did not provide operating reserves in 2030. Further, the average reserve price increased from around $7/MWh to $60/MWh. (NREL,2021)

This leads to a 1.5% increase in total emissions from electricity generation in

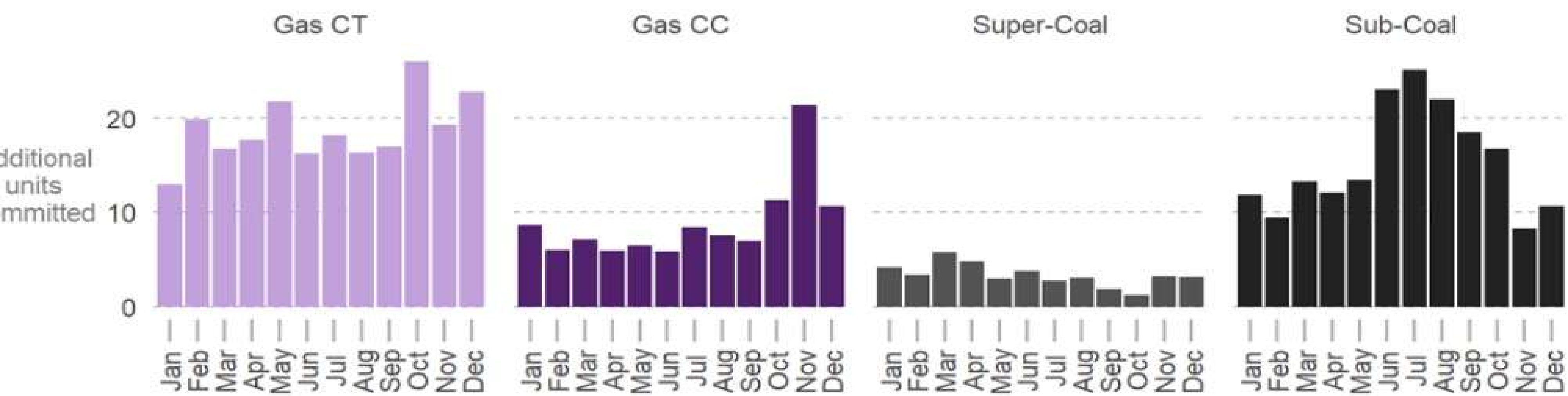


Figure 33. Difference in the average number of units committed when energy storage does not provide operating reserves

Resource adequacy

- If Storage is considered as part of Resource adequacy then capacity Price is paid to them
- If ES is not given Capacity Credit also had a significant impact on the results, with 38% less energy storage deployed by 2030 and 30% less by 2050 compared to the Reference Case. (NREL)
- Without a revenue stream for their contribution to capacity adequacy, the investment potential for energy storage is reduced.
- While energy storage is technically capable of providing reliable capacity, evaluating its contribution to the planning reserve margin requires a systems-level approach.
- Other factors, including the availability of **other peaking resources** and the state of charge of the storage device, also impact the capacity contribution.
- With last few years experience and recent past , there is an issue in getting sufficient Resources on bar during Peak hours.
- When energy storage is not allowed to contribute toward the power system's capacity adequacy requirement, other resources are needed to meet the planning reserve requirement,

A key insight from the regulatory scenarios is that energy storage projects require remuneration for a range of services to achieve their full investment potential.

In the Indian context, this means that new regulatory proceedings at the national and state levels may be needed to enable energy storage projects to provide multiple grid services and to establish agreed-upon methods to quantify and compensate the full value that energy storage provides to the power system.

Regulators can also consider allowing energy storage to participate in the wholesale and real-time energy market . Although there is no bar on this but renumeration is not sufficient on consistent basis to attract Storage.

With proposed new changes like market based Ancillary services, DSM Mechanism and Market based Electricity Dispatch (MBED) situation will be more clear.

Safety of operation

- Safety of operation is a major concern in Utility Scale Storage.
- The Bureau of Indian Standards is now pursuing this task through is Energy Storage Sectional Committee. The committee's efforts are focused on standardization in the field of grid integration of electrical energy storage systems.
- Few Fire incident in USA BESS - 300 MW Moss Landing facility that suffered the battery overheating in Sep,2021 and A Tesla Megapack fire at the Victorian Big Battery in Southeast Australia in August ,2021 raised importance of this issue.
- For time being compliance of UL standards(Global Safety Certification) and IEC standards compliance need to be ensured during procurement process.(UL 9540 or IEC TS 62933-5-1)

Safe Disposal & Circular Economy

As the renewable energy sector grows, high-capacity long-life battery storage is fundamental to its success. How these batteries are designed and made will define their environmental impact for generations to come. Creating a circular economy for batteries is crucial to prevent one of the solutions to the current environmental crisis becoming the cause of another.

Also the possibility of using recycled /used batteries of EV in ESS is being tried.

A circular economy is underpinned by a transition to renewable energy. Two of its principles are to eliminate waste and pollution and to keep products and materials in use. Applying these principles to batteries not only ensures valuable and finite materials like lithium are circulated in the economy, but also helps make the energy transition, and meeting net zero emissions targets, possible

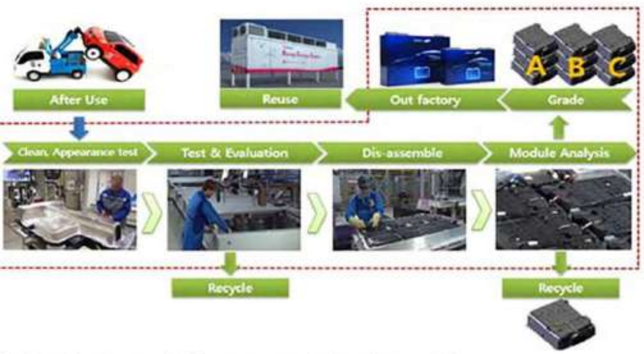
So compulsory recycling and material extraction should be a part of policy

Reuse- Recycle

Figure 4.4: GM-ABB Second-Life Electric Vehicle Battery Applications

Source: Charged Electric Vehicles Magazine, "Nissan, GM and Toyota repurpose used EV batteries for stationary storage," Gharged Electric Vehicles Magazine, 17 6 2015. [Online]. Available: https://chargedevs.com/newswire/nissan-gm-and-toyota-repurpose-used-ev-batteries-for-stationary-storage/. Morris (2015).

Figure 4.10: Second-Life Electric Vehicle Battery Applications



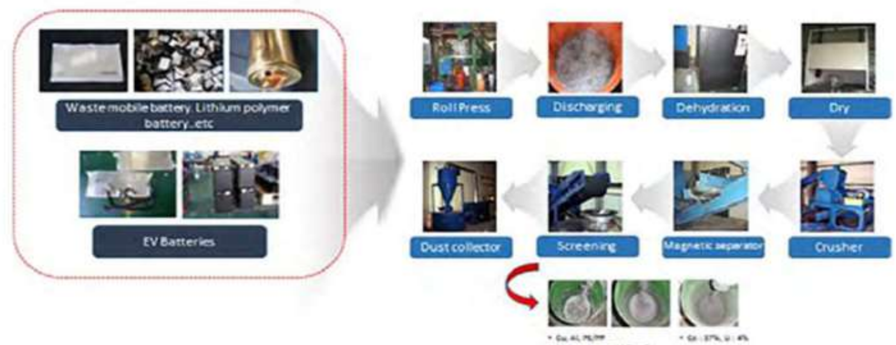
Korea Battery Industry Association 2017 "Energy storage system technology and business model".

Figure 4.12: Chemical Recycling of Lithium Batteries, and the Resulting Materials

$CoSO_4 \cdot 7H_2O$ = cobalt sulfate heptahydrate, $MnSO_4 \cdot H_2O$ = manganese sulfate hydrate, Ni = nickel, $NiSO_4 \cdot 6H_2O$ = nickel sulfate hexahydrate.

Source: Korea Battery Industry Association 2017 "Energy storage system technology and business model".

Figure 4.13: Physical Recycling of Lithium Batteries, and the Resulting Materials



Al = aluminum, C = carbon, Co = cobalt, Cu = copper, EV = electric vehicle, Li = lithium, $LiCO_2$ = lithium ion, PE/PP = polyethylene/polypropylene.

Source: Korea Battery Industry Association 2017 "Energy storage system technology and business model".

@ADB Handbook

Status

Battery storage systems in various states			
	Policy	Regulation	Pilot project
Southren Region			
Tamil Nadu	No specif policy from Govt of Tamil Nadu	No specific regulation about Battery storage systems	TANGEDCO plans to install 3 MW battery storage sysetm with 1 MW solar Power plant at Kariyapatti Substation in Virudhunagar district as a pilot project TANGEDCO plans to set up Solar Power Parks with battery storage system in all the distrcits in Tamil Nadu
.Karnataka	Government of Karnataka issued draft Karnataka RE Policy 2021-26 on 13.10.2021. The draft Policy covers battery Storage Systems.	No specific regulation about Battery storage systems	No pilot project proposed as of now.
Telangana	Government of Telangana issued Electric Vehicle and Energy storage policy for 2020-2030.	No specific regulation about Battery storage systems	No pilot project proposed as of now.
Andhra Pradesh	No specif policy from Govt of AP	No specific regulation about Battery storage systems	1.AP planning for 7 Storage plants with 6300 MW capacity (Pumped Hydro Storage Power projects)
			APTRANSCO Proposed 250-500 MW MW with 2-4 hr storage under Opex Model in MYT for FY 2019-24
Kerala	No specif policy from Govt of Kerala	KSERC issued Regulations on "Renewable Energy and net metering Regulations,2020.	No pilot project proposed as of now.

Vestern Region			
Gujarat	No policy from Government of Gujarat	Discussion Paper issued on Tariff framework for procurement of power by distribution licnesees from Wind -Solar Hybrid projects and other Commercial issues for the state of Gujarat.	Government of India planning to set up around 14 GWH Grid Scale battery storage system @Khavda in Gujarat
Maharastra	No policy from Government of Maharastra		
hhattisgarh	No policy from Government of Chhattisgarh	No specific regulation about Battery storage systems	100 MW (AC) Solar PV Project (160 MWp DC capacity) along with 40 MW/120 MWh BESS at Rajnandgaon, Chhattisgarh
adhya Pradesh	Madhya Pradesh goveremnt issued ' Hybrid Renewable Energy and Energy Storage Policy.'	No specific regulation about Battery storage systems	Madhya Pradesh Power Management Company (MPPMCL) has invited expressions of interest (EOI) for setting up 500MW of grid-scale energy storage capacity as well as a storage manufacturing facility
Eastern Region			
Vest Bengal	No policy from Government of West Bengal	No specific regulation about Battery storage systems	Kolkata Discom CESC and Exide, India's largest battery manufacturer have partnered on a grid connected 315 kWh battery energy storage systems (BESS) at low tension (LT) distribution system for better peak load management.

Status

Northern Region			
Delhi	No policy from Government of Delhi	No specific regulation about Battery storage systems	Tata Power Delhi Distribution Limited (TPDDL) implemented 10 MW “Battery Energy Storage System” at the plant in Rohini.
Rajasthan	Rajasthan Government isued Wind and Solar Policy 2019 which coveres storage	RERC floated Discussion Paper on Framework For Large Scale Integration of Renewable Energy using Energy Storage Systems and its impact on Tariffs	The Government of Rajasthan has been advancing to establish a first-of-its-kind 3.6 GW integrated project including 3,600 MW solar, 900 MW wind and 2,520 MW pump hydro storage plant.
		RERC issued Regulations on "Grid Interactive Distributed Renewable Energy Generating Systems) Regulations, 2021".	
Haryana	Government of Haryana issued draft Haryana Solar Power Policy, 2021 .	No specific regulation about Battery storage systems	The Jhajjar Haryana – Battery Energy Storage System is a 10,000kW energy storage project located in Jhajjar, Haryana, India.
			Indian manufacturer Vision Mechatronics has deployed a lithium-lead-acid hybrid battery storage system coupled with a rooftop solar plant at Om Shanti Retreat Centre (ORC) in the State of Haryana. The 1MWh storage system uses a combination of 614.4 kWh Lithium batteries with a 480kWh tubular-gel lead-acid battery.

Behind the Meter

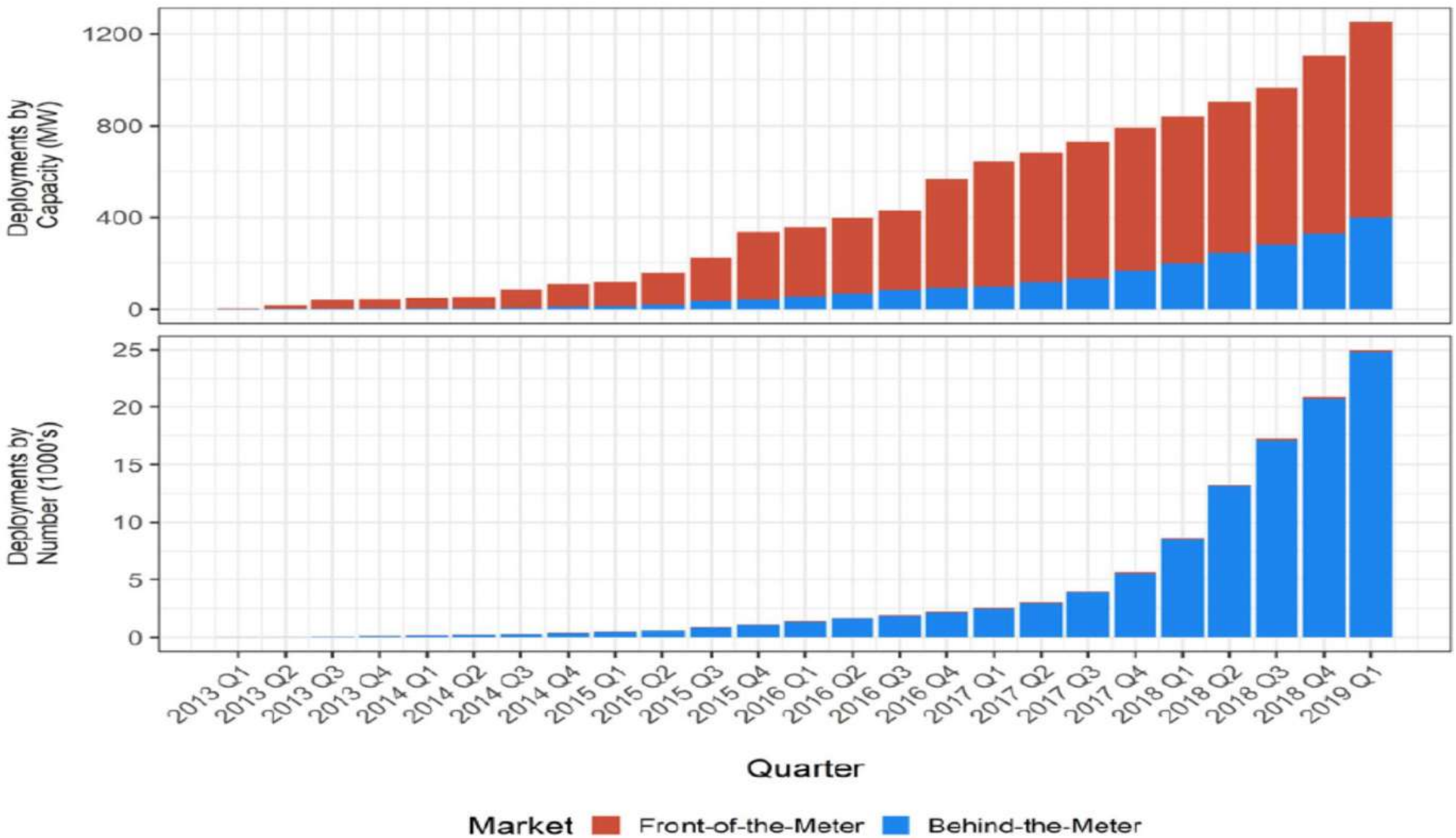
- Recent extreme weather event indicates that there is need of Storage at Retail end .
- Along with the Distributed Solar PV , Storage can be useful in improving reliabilit and flexibility of system .Here too Regulatory and Policy Design need alignment

Figure ES- 1. Approaching regulatory design for DPV-plus-storage systems

Source: Original [*Illustration by Christopher Schwing, NREL]*

Discuss Role c

US Storage Deployment



BTM Market Projection 27.4 GW

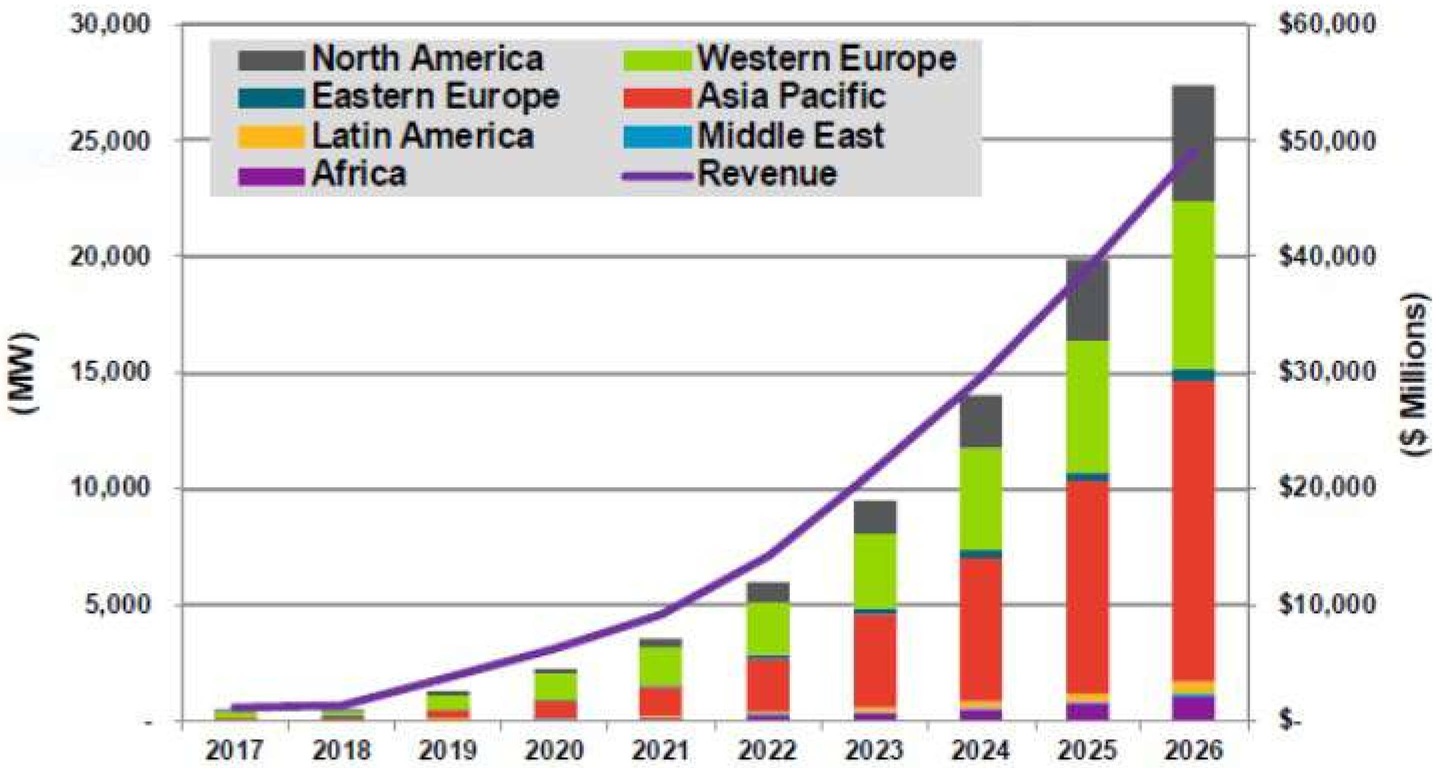
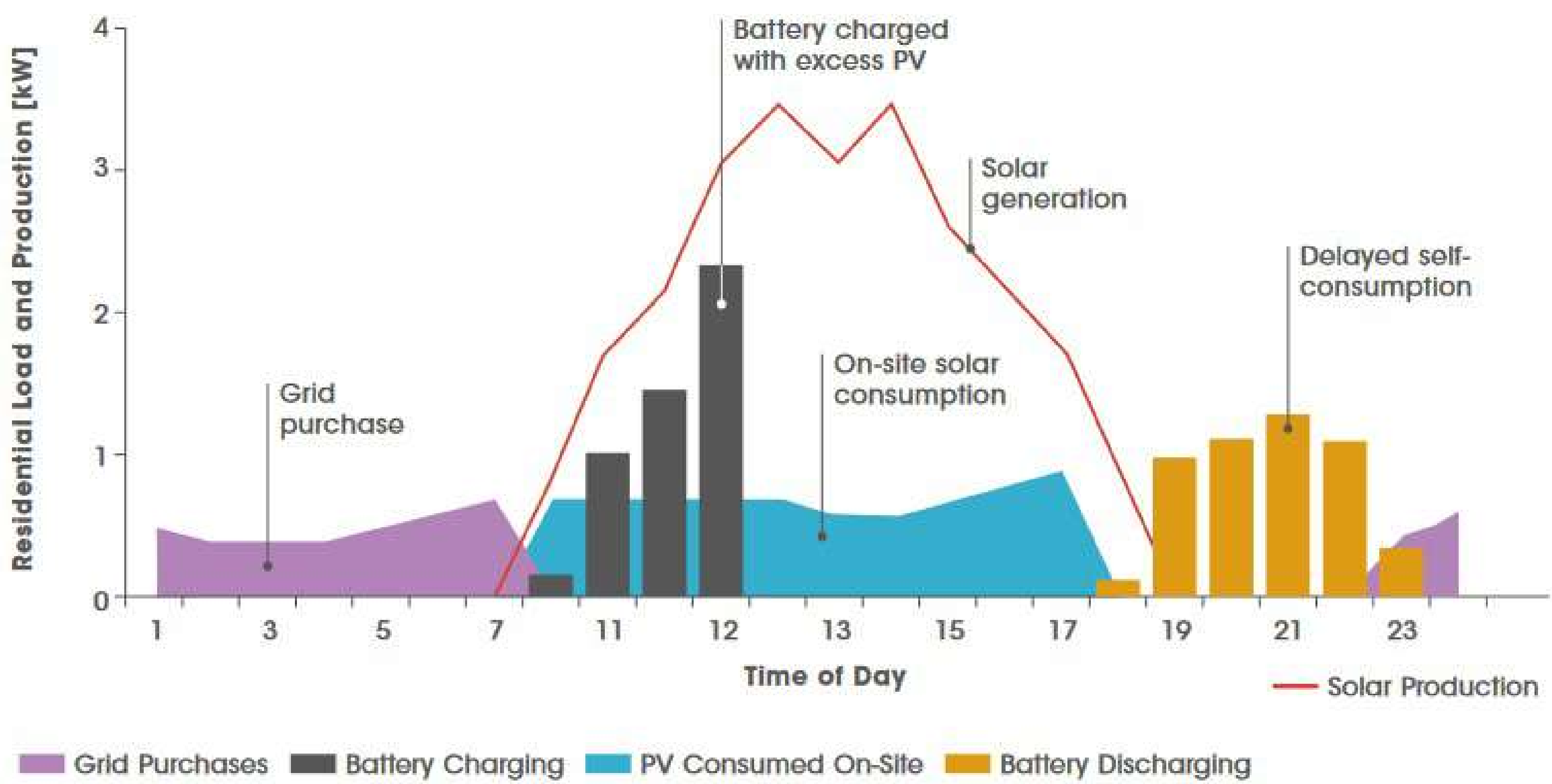


Figure 6. Estimated annual distributed grid and off-grid PV-plus-storage power capacity and expected vendor revenue by region, world markets: 2017-2026

Source: Tokash and Dehamma 2017

Typical Cycle

Figure 5: Typical solar PV production and battery charging/discharging schedule



Policy for DPV-Plus Storage

Regulatory decisions are made in the broader context of a policy and market environment. This policy and market context influences all other steps in the decision-making process.

These include :

- Storage Deployment Mandates
- Nonbinding Storage Goals
- Renewable Portfolio Standards and Clean Peak Standards
- Direct Financial Incentives
- Distribution Network Service Provision
- Wholesale Market Participation
- Distribution Market Structure
- Distribution Company Performance Standards

The latter two points have important implications for financing, investment, ownership, and operation and maintenance of DPV-plus-storage projects, as well as the fostering of competitive markets where new service providers have access alongside incumbent distribution utilities.

Drivers of BTM

The key drivers of residential and commercial behind-the-meter storage deployment include

Increasing customer interest in self-consumption of distributed generation

Resilience,

Metering and billing arrangements(NEM, Net billing , Buy all or sell all)

Retail tariff design changes, such as net energy metering (NEM) and time-of-use (TOU) rates, that help to drive customer bill savings,

Grid service opportunities

Policy and regulatory mandates and incentives

System cost reductions

Role of Regulator in Design

Design Dimensions

- Customer Class
- Voltage Interconnection level
- System Capacity
- Consumption Magnitude
- Geography
- Local Grid Conditions

mportant Role of Regulator

Develop and Prioritize Regulatory Objectives

Design Compensation Mechanism

Design Metering and Technical Configuration

Design Interconnection Process

Consider Local Permitting Issues

Key Consideration for Regulators

Determine the desired role of DPV-plus-storage: DPV-plus-storage has a significantly broader set of capabilities to offer customers and the power system, and regulators are often able to guide how these resources are ultimately utilized.

- To primarily serve a customer's own energy demand, and/or for individual customer backup purposes during grid outages.
- Others may wish to enable DPV-plus-storage systems to provide grid services to the power system.

Customizing rules and requirements based on the characteristics of the DPV-plus-storage system is a key strategy for promoting fairness.

- Creating distinct sets of compensation mechanisms, metering and technical configuration requirements, and interconnection processes—which may be based on system size, the intended use of the system (e.g., an exporting versus non-exporting storage system)

Key Consideration for Regulators

Market context strongly influences compensation mechanism design and its timing.

- Solar penetration levels,
- Grid management issues,
- Storage deployment mandates or goals,
- Distributed energy resource (DER) technology costs,
- Utility cost recovery and
- cross-subsidization considerations, and
- low-income customer concerns

The presence of higher penetrations of solar photovoltaics may create certain grid management issues (e.g., the "duck curve") that could motivate the utilization of more granular, cost-reflective rates (e.g., time-of-use [TOU] tariffs) and/or alternatives to net energy metering (NEM) to better align customer and grid system needs.

On the other hand, jurisdictions which have financially insolvent utilities or significant cross-subsidy schemes in place may be more concerned with ensuring utility revenue sufficiency and avoiding cost-shifting, and may wish to encourage the use of customer-sited storage deployment primarily for self-supply and/or backup during grid outages.

Key Consideration for Regulators

Tariff design is the primary tool to align the interests of DPV-plus-storage customers with the broader power system.

- Relative to grid-tied DPV systems, the presence of a paired behind-the-meter storage system allows customers to better control the magnitude and timing of their electricity consumption from the grid, as well as their grid exports.
- TOU volumetric energy rates and coincident demand-based charges, if designed and implemented properly, can take advantage of this load shifting capability and incentivize DPV-plus-storage customers to act in a more grid-optimal manner (e.g., reducing consumption and/or increasing exports during typical peak demand periods).
- This behavior, as incentivized by time-variant tariffs, can help ease the management of DERs on the distribution system and also lead to a reduction in power system operational costs.
- Implementation of such tariffs may require new metering equipment and administrative responsibilities for utilities but can serve as a grid-friendly incentive for customers to install DPV-plus-storage systems.

Key Consideration for Regulators

Regulators can help balance common utility concerns with consumer interests, ensuring the implementation cost of solutions is commensurate with the scale of the issue being created.

Utilities may raise concerns over issues such as compensation mechanism integrity, energy arbitrage activities, or inadvertent exports from storage systems.

Regulators are in a position to balance utility and customer interests and ensure that utility proposals to mitigate their concerns do not place an undue burden on participating and nonparticipating customers.

For instance, while undesirable energy arbitrage could be mitigated through the deployment of additional metering equipment, the cost of installing additional metering equipment might be inappropriately high for smaller scale residential, commercial, or industrial customers.

Key Consideration for Regulators

Regulators can enable business model innovation for DPV-plus-storage systems.

Regulators can play a key role in allowing alternative investment and ownership models for DPV-plus-storage systems. (Blockchain Peer To Peer)

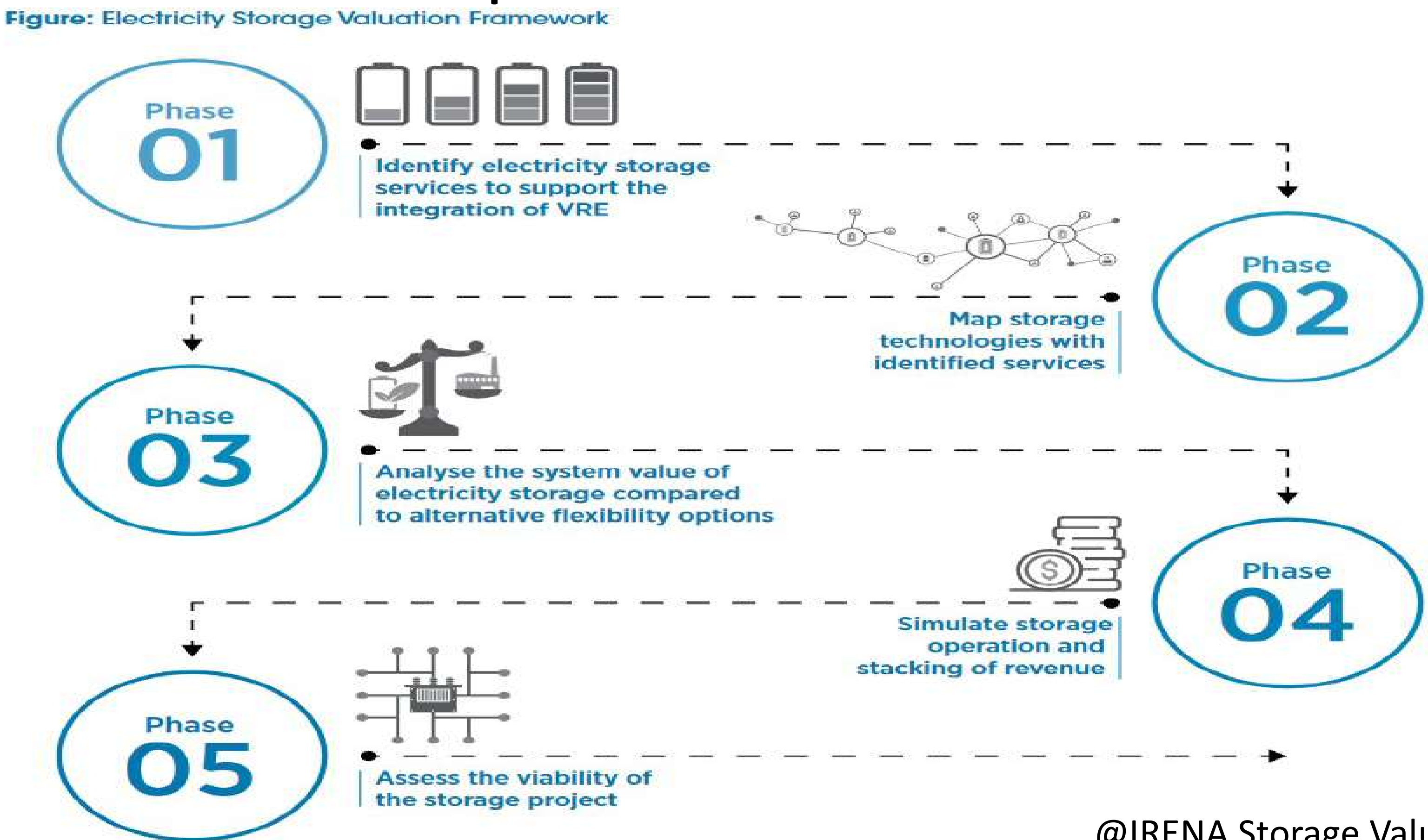
Many DPV assets have been deployed under third-party ownership models (either lease or power purchase agreement) whereby a utility customer does not actually own the asset but receives a portion of the benefit of the DPV generation.(Similar to RESCO)

Third-party ownership models are already beginning to play a role in storage deployment in the United States, Australia, and elsewhere, both fo retrofits and new-build DPV-plus-storage systems.

In the future, these resources might be aggregated by third parties, who are allowed to do so to provide valuable services to distribution companies and/or the bulk power system.

Regulators can play a key role in enabling the participation of aggregators, and, in some cases, defining how aggregators are allowed to operate.

Evaluate all options



@IRENA Storage Valuation

Festival Season Good News

- A high Power Group under Member (GO&D),CEA finalised Bidding Guidelines for Energy Storage System as part of Generation, Transmission and Distribution assets along with Ancillary Services .
- 1000 MWh Project in two phases of 500 MWh
- Based on this SECI issued Tender Document. Prebid soon on 28.10.2021
- Unique Model where 70 % Power to State and 30% to POSOCO for system operation.
- MOP Invited Comments of stakeholders on Energy Storage Policy –Last Date 31.10.2021
- Four Working groups are burning midnight Oil or using all Stored experience and knowledge to formulate Technology, Regulatory and Policy , Finance and Taxation issue and Demand Management for Storage Policy Formulation.
- Both BESS and PHS competing for eyeballs and support .
- Green DAM started.
- Ministry of power notified RE as Must Run and prohibited curtailment except due to Grid Security .

Desire-Aspire-Perspire-Inspire

"The key to realizing a dream is to focus not on success but on significance -- and then even the small steps and little victories along your path will take on greater meaning."-Oprah Winfrey

Thank You very much for your valuable time and attention


There's no harm in hoping for the best as long as you're prepared for the worst.
Stephen King
quotefancy